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(54) Fuel supply system

(57) A fuel supply system for supplying fuel to an engine has a common rail (11) and injectors (14,15,16) which are located inside a housing (17), e.g. a rocker cover, of the engine. The injectors (14,15,16) are mounted directly on the common rail (11) rather than being connected to the common rail (11) by connection lines.

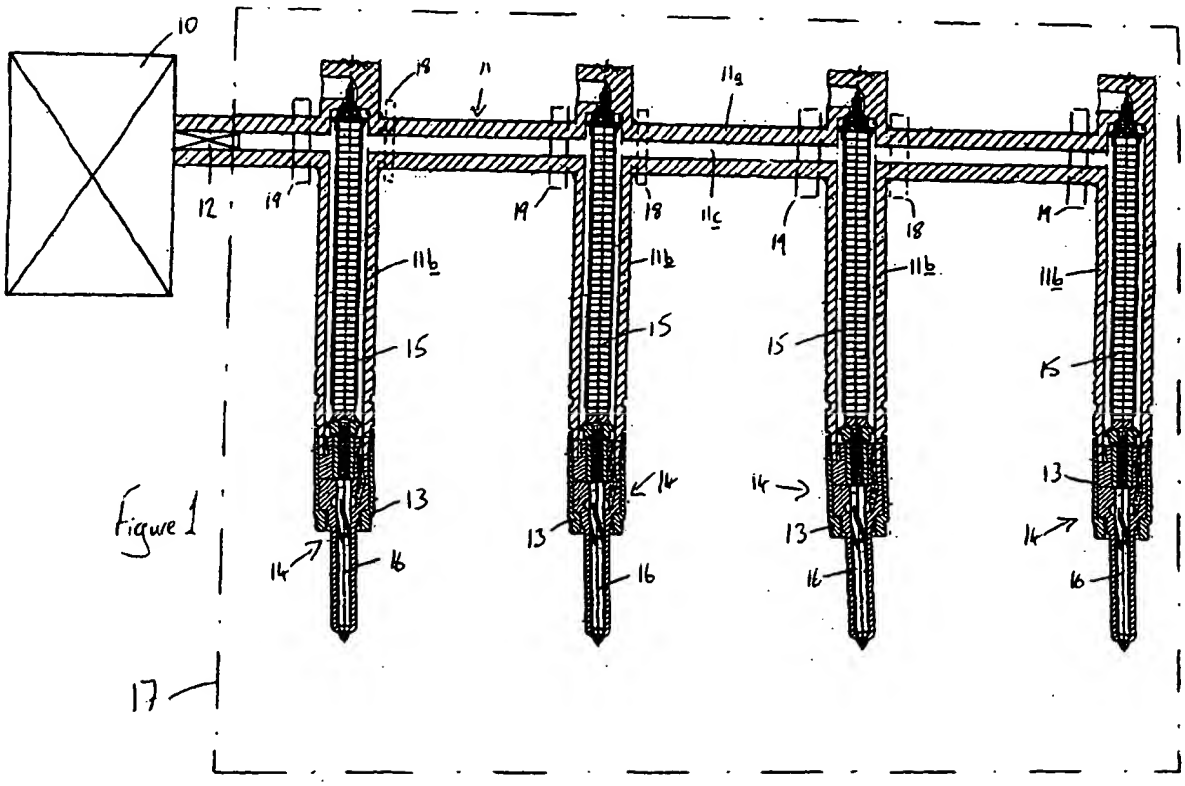

Figure 1

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Description

[0001] This invention relates to a fuel supply system for use in supplying fuel under high pressure to the combustion spaces of a compression ignition internal combustion engine. The invention relates, in particular, to a fuel system of the common rail type.

[0002] A common rail fuel system typically comprises a common rail in the form of a high pressure pipe which is charged to a high pressure by an appropriate high pressure fuel pump. A plurality of connection lines are connected to the common rail, each connection line leading to a respective fuel injector. Such a system is composed of a large number of components and a large number of high pressure seals must be formed between the various components. The high number of seals gives rise to a risk of fuel leakage. Further, the common rail is typically located outside of the engine housing where such a leakage may constitute a fire risk.

[0003] According to a first aspect of the invention, there is provided a fuel system for supplying fuel to an engine, said system comprising a common rail to which a plurality of injectors are connected, the common rail being located or adapted to be located, inside of a housing of the engine.

[0004] According to another aspect of the invention there is provided a fuel system comprising a common rail and at least one injector mounted directly upon the rail.

[0005] The common rail is preferably located within the engine rocker cover.

[0006] The common rail conveniently takes a suitable form to permit the injectors to be mounted directly thereto. The common rail may be a one piece construction, or alternatively may be composed of a plurality of components, injectors being mounted upon either some or all of the components.

[0007] The component(s) may form part of the injector (s), or may define one or more coupling regions upon which the injectors are mounted.

[0008] By locating the common rail within the engine housing, the fire risk is reduced as compared with known systems where the common rail is located externally of the engine. Also, by mounting the injectors directly upon the common rail rather than using separate connection lines, the number of high pressure seals, and hence the risk of leakage, is reduced.

[0009] The invention will further be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 illustrates a fuel system in accordance with an embodiment of the invention and some modifications thereto; and

Figure 2 is a view similar to Figure 1 illustrating an alternative embodiment.

[0010] The fuel supply system illustrated in Figure 1 comprises a fuel pump 10 which, in use, is mounted upon an engine in such a manner as to be driven by the engine. The outlet of the pump is connected to a common rail 11 which takes the form of a one piece forging. At the inlet of the common rail 11, a filter 12 is mounted, the filter 12 being arranged to remove particulate contaminants of dimensions greater than a predetermined level from the flow of fuel to the common rail 11.

[0011] The common rail 11 includes a first region 11a extending in a first direction, and a plurality of laterally spaced second regions 11b which extend transverse (in this embodiment, perpendicular) to the first direction and which are of relatively long axial extent. Each of the second regions 11b defines a deep recess communicating with an internal bore 11c which extends along the length of the first region 11a. An end of each of the second regions 11b remote from the first region 11a, is provided with an external screw thread to which a cap nut 13 is secured, the cap nut 13 being used to mount an injection nozzle 14 to that end of each second region 11b. It will be appreciated that the second regions 11b serve, in effect, as nozzle holders for the injector nozzles 14.

[0012] In the illustrated arrangement, each injector, in addition to the nozzle 14, also includes a piezoelectric actuator stack 15 which is located within the deep recess formed in the associated second region 11b. Thus, in effect, each second region 11b forms a housing of the injector which it supports and, in this embodiment, houses the piezoelectric actuator stack 15.

[0013] By appropriately controlling the energization level of the piezoelectric actuator stack 15, a valve needle 16 of the nozzle 14 can be moved between a closed position in which it engages a seating, preventing the flow of fuel from the common rail past the seating to a plurality of outlet openings, and a position in which the needle 16 is lifted from its seating, thus permitting fuel injection to take place.

[0014] The common rail 11 is located within a housing of the engine, as denoted by line 17 in Figure 1. In this embodiment, the housing 17 is a rocker cover of the engine, i.e. a cover for part of the mechanism used to open and close inlet and exhaust valves of the engine. As a result, the common rail fuel system is relatively compact, and the risk of leakage of fuel at high pressure from the engine is reduced. Further, by arranging for the injector nozzles 14 to be mounted directly upon the common rail 11, the provision of separate connection lines to each injector is avoided, and the number of component parts is reduced. By reducing the number of component parts, the number of high pressure seals which must be provided in the fuel system can be reduced, thus further reducing the risk of leakage of fuel.

[0015] A further advantage associated with using the invention in conjunction with the injectors of the type illustrated in Figure 1 is that, as the recesses of the second regions 11b of the common rail 11 serve to store a

quantity of fuel at high pressure, the dimensions of the bore 11c of the common rail 11 can be reduced compared to other arrangements. The reduction in the size of the bore 11c may be accompanied by a reduction in the outer diameter of the first region 11a, resulting in the common rail 11 being of increased flexibility. The flexibility may compensate for slight tolerance variations in the manufacture of engines and for differential thermal expansion, in use. Also, as the injectors extend through the common rail 11, the height of the system can be reduced.

[0016] Although in the arrangement illustrated in Figure 1, the common rail 11 is of one piece construction, if desired, the common rail could be constructed of a plurality of component parts. For example, the common rail 11 could be broken into a plurality of parts of generally L-shaped form, the parts being connected together by appropriate high pressure seals located at the locations denoted by dashed lines 18. In this modification, as illustrated in Figure 1, the forging furthest to the right is different from the remainder of the forgings as the bore 11c does not extend from both sides of the second region 11b of that forging. However, it may be desirable to manufacture only a single type of forging, and in that case, the bore 11c would extend laterally completely through the second region 11b of that forging, and an appropriate seal used to plug the bore or an appropriate connection made to connect the bore to an appropriate reservoir. Alternatively, both ends of the bore could be connected, through appropriate passages and filters, to the outlet of the high pressure pump.

[0017] In a further modification illustrated in Figure 1, rather than manufacture a plurality of generally L-shaped components, the common rail may comprise a plurality of tubular member and a plurality of parts constituting the nozzle holders of the injectors, the parts being sealed together at both the locations denoted by dashed lines 18 and the locations denoted by dashed lines 19.

[0018] The modifications illustrated in Figure 1 which use high pressure seals located at the locations 18 or both the locations 18 and the locations 19 can be used with a wide variety of engines including engines having different numbers of cylinders, as the number of injectors present in the system can be changed simply by adding or removing components to or from the fuel supply system. The modifications including such seals may further be advantageous in that a greater degree of flexibility may be present in such systems than in the arrangement illustrated in Figure 1 in which the common rail 11 is of one piece construction. Such flexibility may assist in properly mounting the injectors within the engine.

[0019] Although in the arrangement illustrated in Figure 1 and the modifications thereto, a piezoelectric actuated injector is used, and has certain advantages, it will be appreciated that the invention is suitable for use with any fuel injector of the type suitable for use with a common rail fuel system, and is not limited to the particular type of injector illustrated in Figure 1.

[0020] Figure 2 illustrates the use of the invention with a different type of injector, the injector illustrated in Figure 2 being of the electromagnetically actuable type. In the arrangement of Figure 2, rather than securing the cap nut of the injector directly to the common rail 11 as in Figure 1, the nozzle holder of the injector is modified to incorporate a region provided with, for example, a screw thread which is used to mount the injector upon the common rail 11. It will be appreciated, however, that if desired, the injector could be modified such that the cap nut is used to secure the injector to the common rail. In the arrangement of Figure 2, the common rail 11 has been modified such that the second regions 11b are of relatively short axial length, thus avoiding any unnecessary increase in the size of the system. The second regions 11b define relatively large diameter volumes for storing fuel under high pressure, serving as accumulators for the associated injector, and thus permitting the bore 11c of the common rail 11 to be of relatively small diameter giving rise to the advantage that the common rail 11 is relatively flexible as discussed hereinbefore. As mentioned hereinbefore, the common rail 11 may take the form of a single part construction or may be composed of several components secured to one another using appropriate high pressure seals at the locations 18, 19 as discussed hereinbefore in relation to Figure 1.

[0021] The arrangements described hereinbefore are advantageous in that the risk of fuel leakage and the associated fire risk can be reduced by using a reduced number of high pressure seals and by enclosing the system within the engine housing.

Claims

1. A fuel system for supplying fuel to an engine, said system comprising a common rail (11) to which a plurality of injectors (14,15,16) are connected, characterised in that the common rail (11) is adapted to be located inside of a housing (17) of the engine.

2. A fuel system as claimed in claim 1, wherein the housing (17) is an engine rocker cover.

3. A fuel system as claimed in claim 1 or 2, wherein the injectors (14,15,16) are mounted directly on the common rail (11).

4. A fuel system comprising a common rail (11) and at least one injector (14,15,16), characterised in that said at least one injector (14,15,16) is mounted directly upon the rail (11).

5. A fuel system as claimed in claim 3 or 4, wherein the common rail (11) includes a first region (11a) ex-

tending in a first direction and a plurality of second regions (11b) extending transversely to said first direction, and each of the injectors (14,15,16) is mounted on a respective one of the second regions (11b).

6. A fuel system as claimed in claim 5, wherein a part (15) of each injector extends within a fuel storage recess in a respective one of the second regions (11b).

7. A fuel system as claimed in claim 5, wherein a fuel storage recess is defined in each of the second regions (11b), and each injector (14,15,16) is disposed externally of the respective second region (11b).

8. A fuel system as claimed in any preceding claim, wherein the common rail (11) is of one piece construction.

9. A fuel system as claimed in any one of claims 1 to 7, wherein the common rail (11) is composed of a plurality of components, and injectors (14,15,16) are mounted upon some or all of the components.

10. A fuel system as claimed in any one of claims 1 to 7, wherein the common rail (11) is composed of a plurality of components which form part of the injectors.

11. A fuel system as claimed in any one of claims 1 to 7, wherein the common rail (11) is composed of a plurality of components which define one or more coupling regions upon which the injectors are mounted.

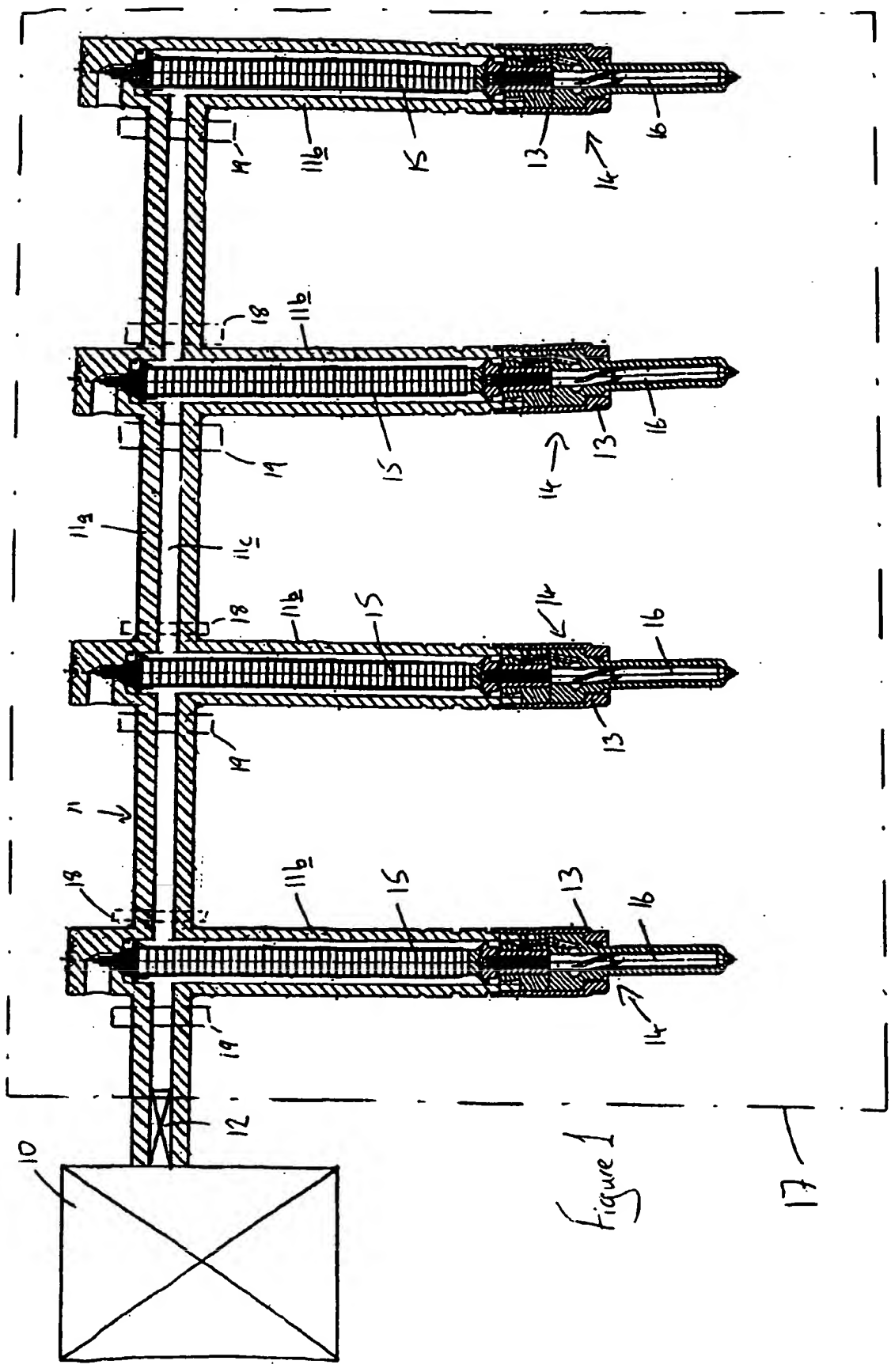

Figure 1

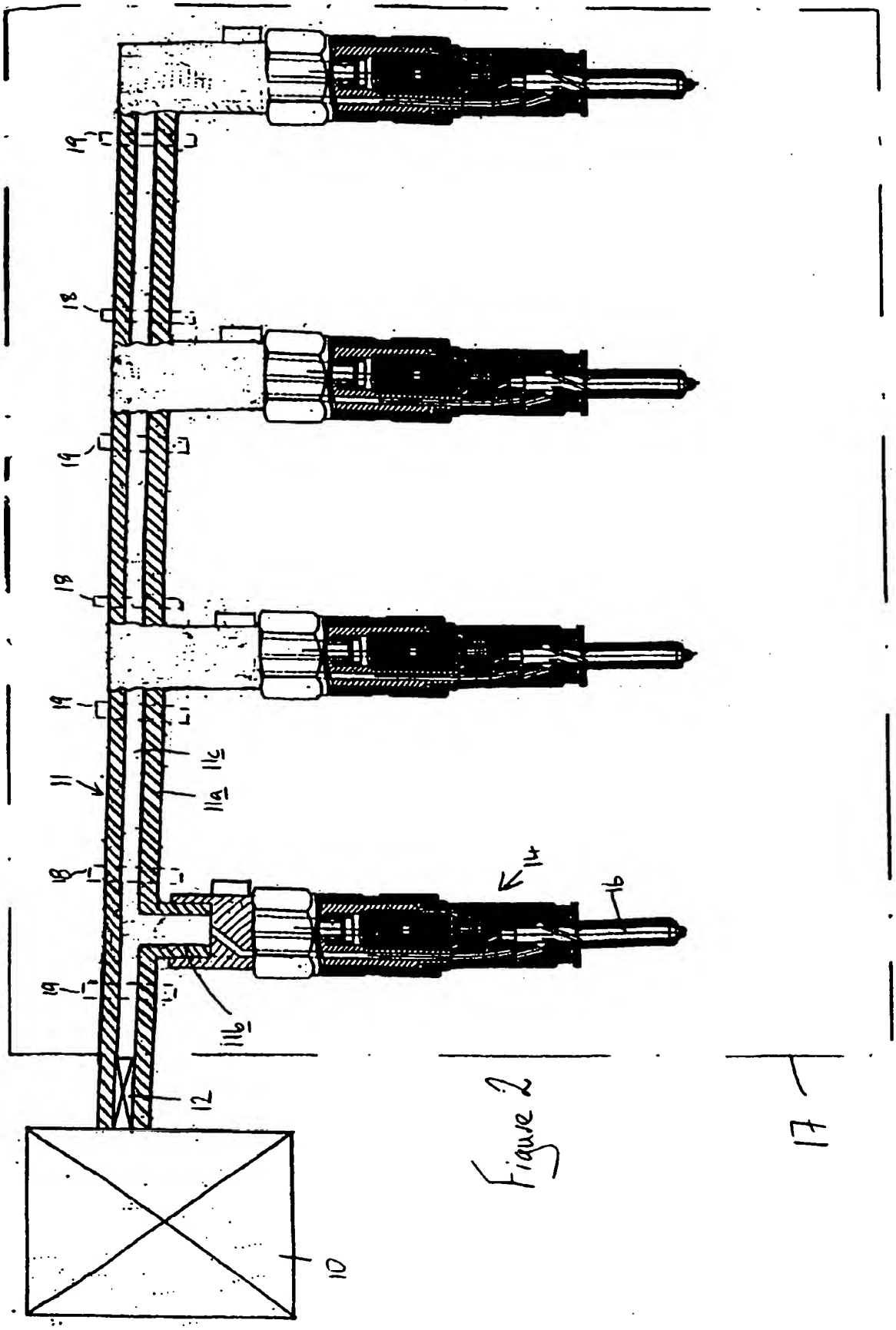

Figure 2

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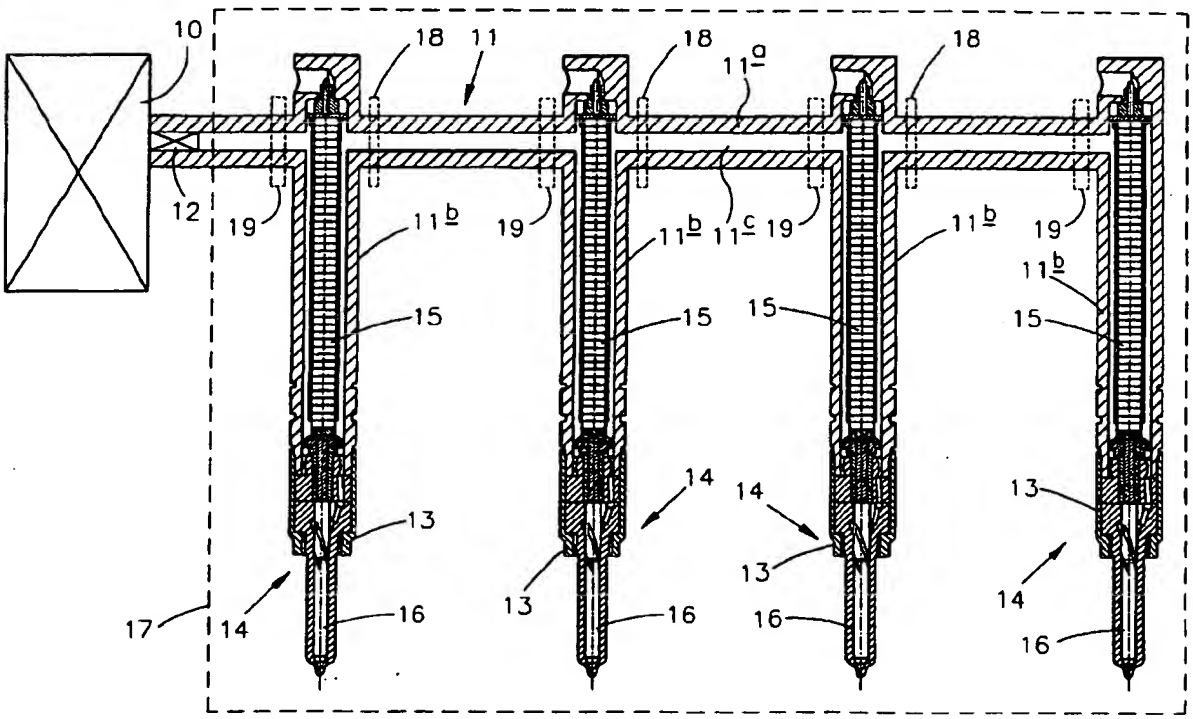

FIG 1

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EUROPEAN SEARCH REPORT

Application Number
EP 00 30 5314

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	DE 197 50 298 A (MAN NUTZFAHRZEUGE AG) 20 May 1999 (1999-05-20) * column 1, line 50 - line 66; figure 1 *	1,2,8,9 3,5-7	F02M55/02 F02M61/14 F02M69/46 F02M63/02
Y A	WO 92 16736 A (BOSCH GMBH ROBERT) 1 October 1992 (1992-10-01) * page 5, line 14 - paragraph 29; figures 1-3 *	3,5-7 8,9	
X	EP 0 704 619 A (DAIMLER BENZ AG) 3 April 1996 (1996-04-03) * abstract; figure 1 *	1,2,8,9	
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 11, 29 November 1996 (1996-11-29) & JP 08 189441 A (TOYOTA MOTOR CORP;OTIX:KK), 23 July 1996 (1996-07-23) * abstract *	3,5-7,9	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F02M

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
MUNICH	13 February 2003	Kolland, U

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 00 30 5314

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-3, 5-11

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 00 30 5314

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-3,5-11

   The common rail is "adapted to be" located inside of a housing of the engine. With this aarangement fire risk is reduced.

2. Claim : 4

   At least one injector should be mounted directly upon the rail. This should reduce the risk of leakage.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 30 5314

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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13-02-2003

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